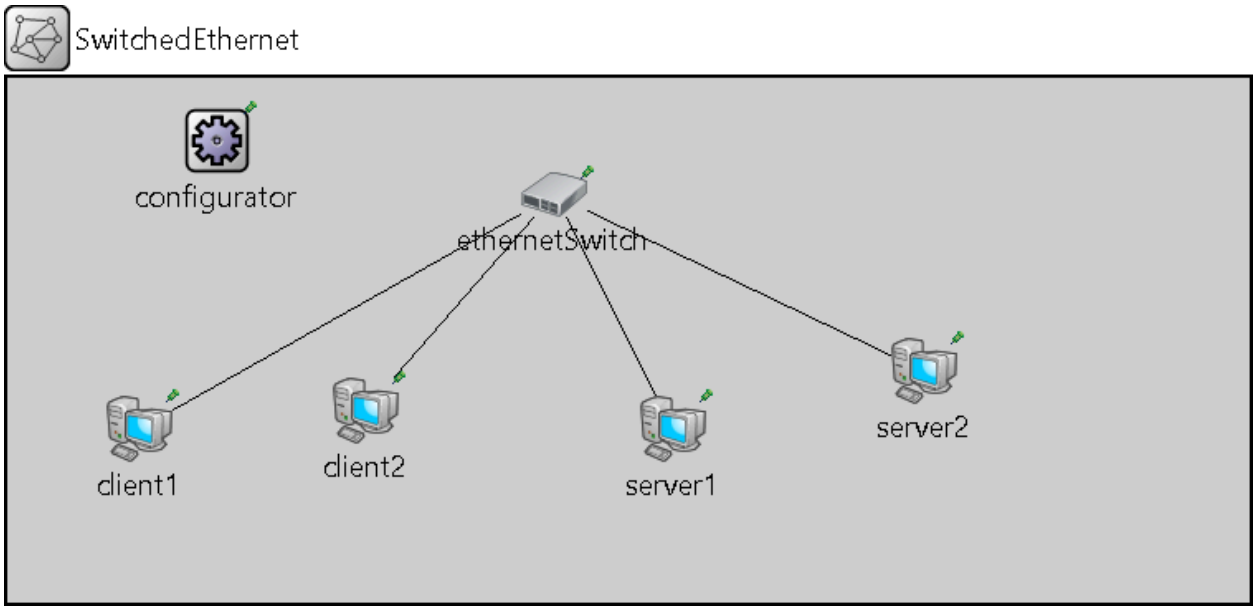
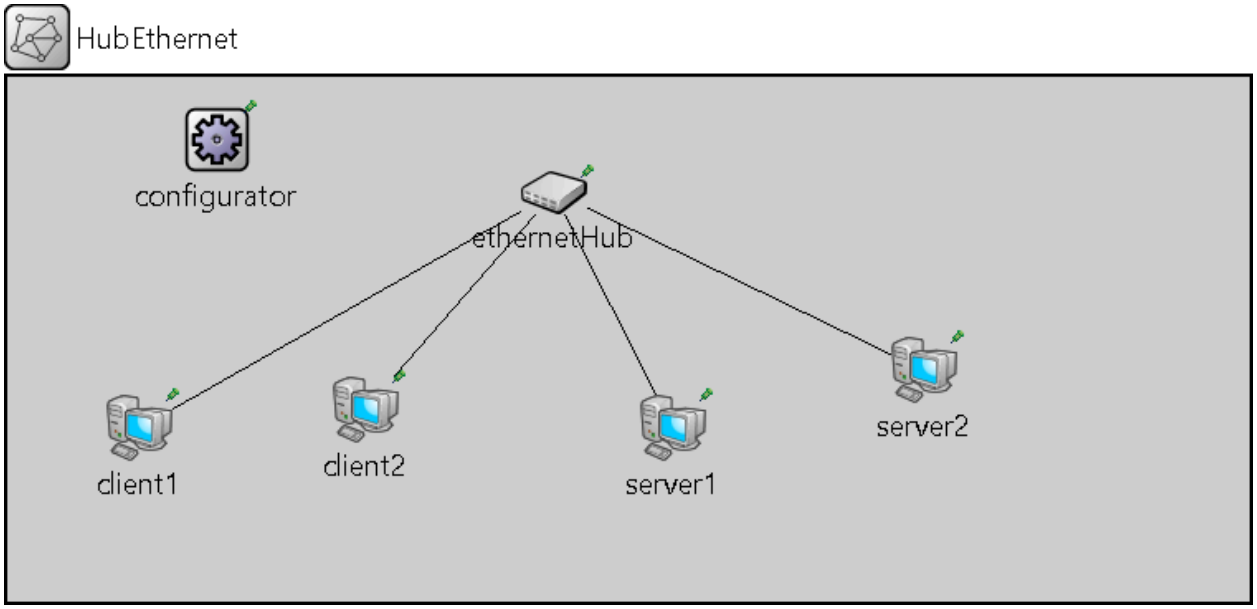
ECE/CS 5565: Project 1
Fall 2024

1. Network Simulation

1.1 Network Images

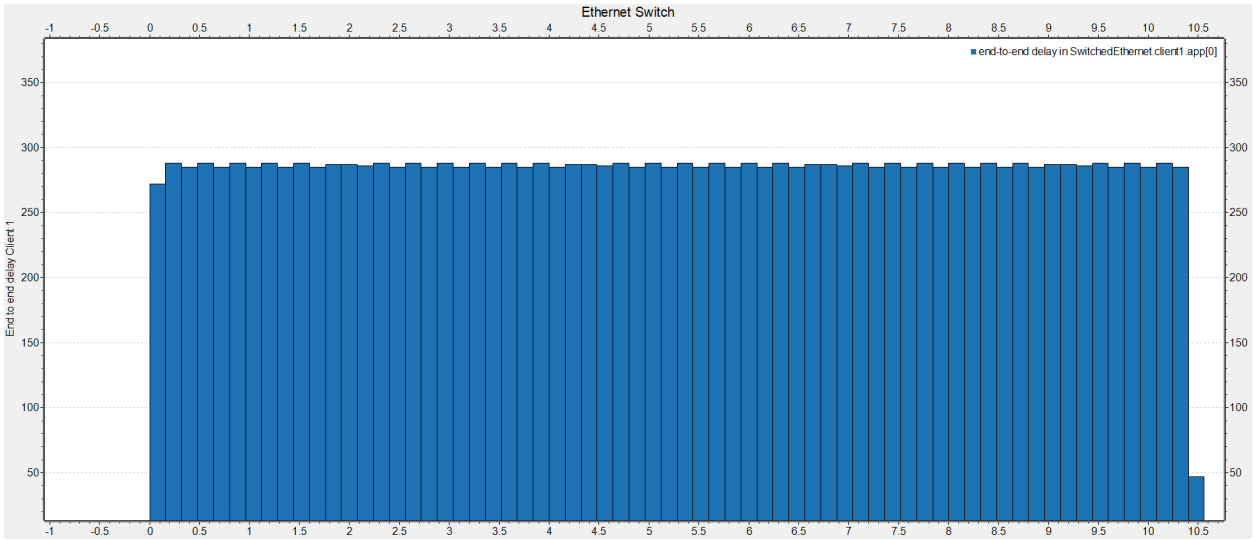




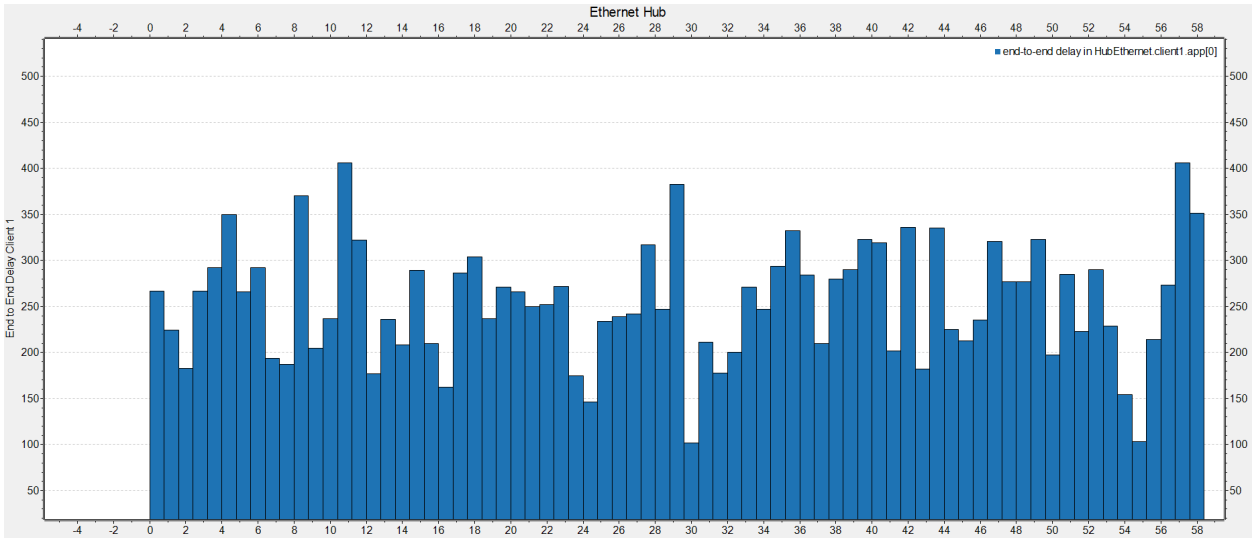
1.2 Table of Numerical Results

Node	Value Type	Mean	Standard Deviation
Client 1 (Ethernet Switch)	End-to-end delay	5.217	3.008
Client 1 (Ethernet Hub)	End-to-end delay	29.335	17.008

1.3 Histograms



Ethernet Switch Client1 E2E delay



Ethernet Hub Client1 E2E delay

1.4 Comparison

The Ethernet Hub has higher end-to-end latency than Ethernet Switch and higher fluctuations in end-to-end delays as reflected in the higher standard deviation. The differences arise due to the way both of them operate.

Ethernet Hub operates at the physical layer of the OSI model which broadcasts data to all the ports leading to **inefficient** data transmission and transmits data using the same communication medium for all data transfers leading to **high collisions** and **retransmissions** especially during high traffic (reflected in the fluctuations in the histogram).

The Ethernet Switch operates at the data link layer of the OSI model which transmits data to its intended port and uses different communication mediums for different ports leading to **lesser collisions** and **retransmissions**.

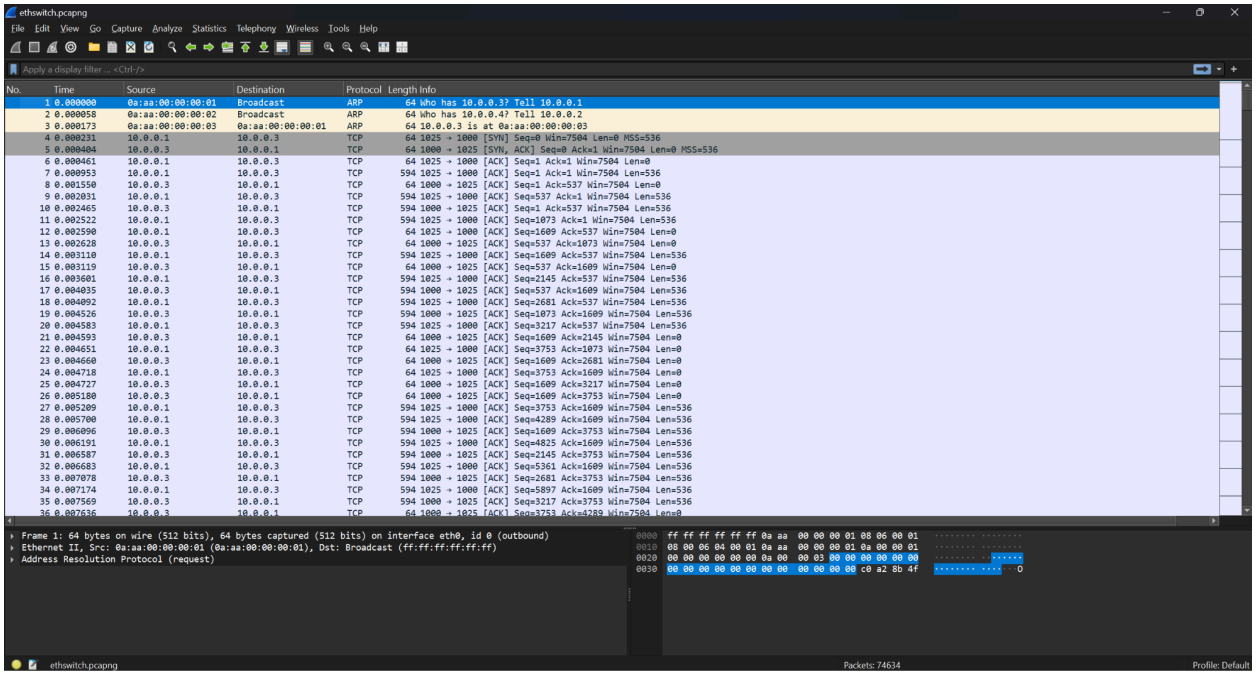
Overall, **Ethernet Switch** is more **efficient** and handles high traffic better, leading to **lower** mean latency values and **lesser** deviation in latency values.

1.5 Discussion

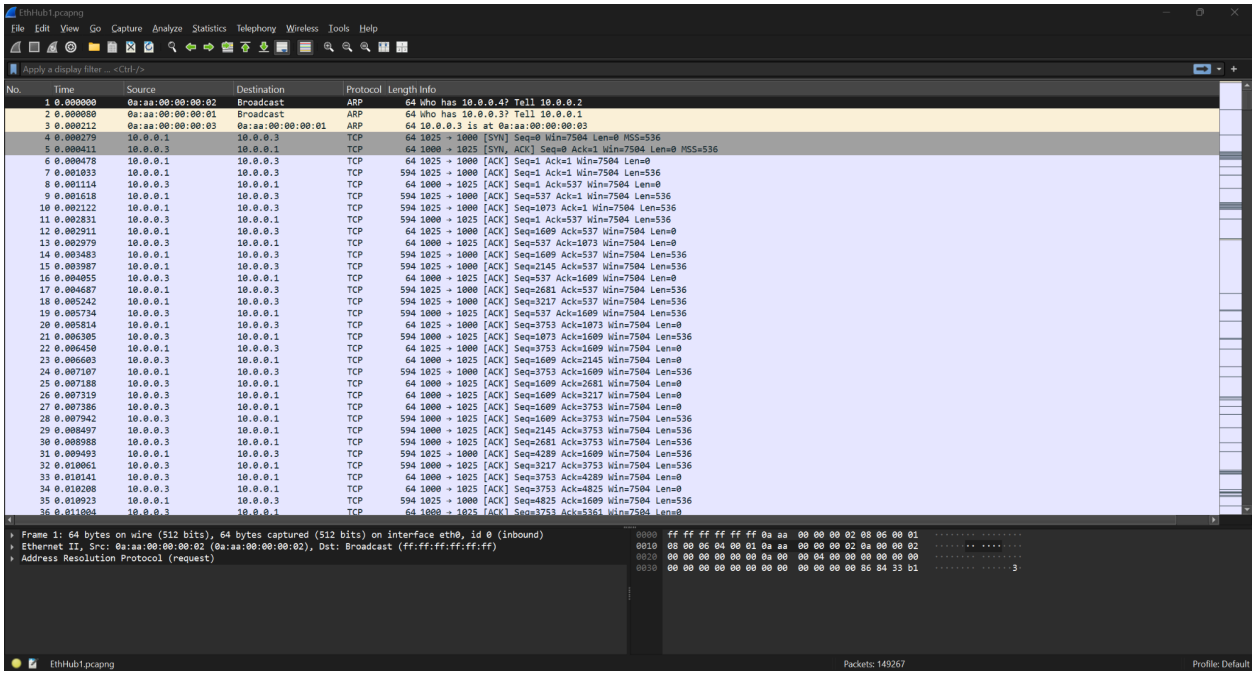
No problems were encountered in the Omnet++ simulation.

2. Wireshark

2.1 Images of Wireshark Windows



Ethernet Switch Wireshark



Ethernet Hub Wireshark

2.2 Questions for Network with Ethernet Switch

a. Client1: 0a:aa:00:00:00:01
   Client2: 0a:aa:00:00:00:02
   Server1: 0a:aa:00:00:00:03
   Server2: 0a:aa:00:00:00:04 (Speculation)

b. Client1: 10.0.0.1
   Client2: 10.0.0.2
   Server1: 10.0.0.3
   Server2: 10.0.0.4

c. Frames 1,2 and 3 utilize **Address Resolution Protocol (ARP)**. Frames 1 and 2 are ARP requests from Client1 and Client2 to map the IP addresses 10.0.0.3 and 10.0.0.4 to their mac addresses. Frame 3 is an ARP reply from 10.0.0.3 communicating its IP address to the respective client.

d. Frames 4,5 and 6 establish a **TCP** 3-way handshake connection between Client1 and Server1. In Frame 4, Client1 sends a SYN packet to establish a connection with Server1. In Frame 5, Server1 sends an SYN-ACK packet, acknowledging Client1's request. In Frame 6, Client1 sends an ACK packet acknowledging the establishment of the TCP connection. Overall TCP protocol is used.

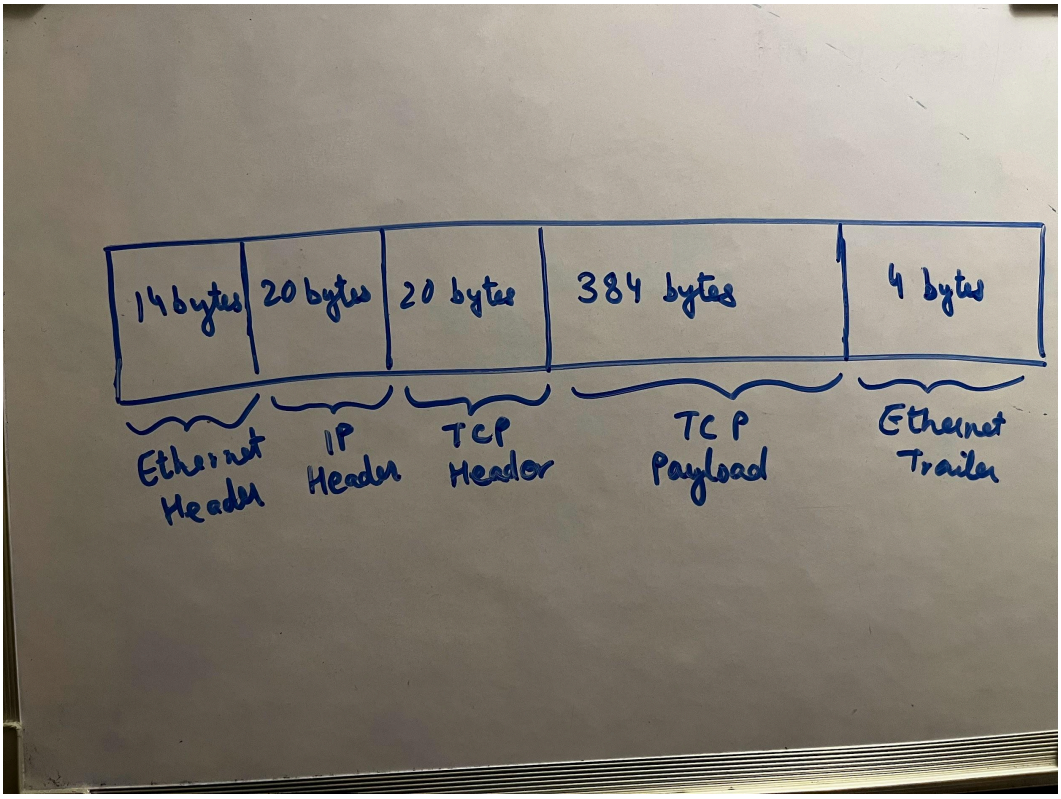
e. Frame 7 carries the first block of data. It is recorded at 0.000953s.

f. Frame 74633 carries the last block of data. It is recorded at 10.425444s.

g. Source Ethernet Address: 0a:aa:00:00:00:03
   Destination Ethernet Address: 0a:aa:00:00:00:01

   Source IP Address: 10.0.0.3
   Destination IP Address: 10.0.0.1

   Source Port Number: 1000
   Destination Port Number: 1025

h. 

i. Bytes transferred from Client1 to Server1: 12MB
Duration of conversation: 10.4253s
Effective Bit rate Client1 -> Server1: 9420 kbps

2.3 Questions for Network with Ethernet Hub

Assuming the IP addresses to be the same as that of Ethernet Switch i.e.

Client1: 0a:aa:00:00:00:01
Client2: 0a:aa:00:00:00:02
Server1: 0a:aa:00:00:00:03
Server2: 0a:aa:00:00:00:04

We can proceed with the answers of the following subsections

a. Frame 7 carries the first block of data. It is recorded at 0.001033s.

b. Frame 147424 carries the last block of data. It is recorded at 58.348568s.

c. Bytes transferred from Client1 to Server1: 12MB
Duration of conversation: 58.3527s
Effective Bit rate Client1 -> Server1: 1683 kbps

2.4 Comparison

For both scenarios, the same amount of data is transferred. However the duration is **more** for Ethernet Hub resulting in a **lower** Effective Bit rate (9420 kbps for switch vs 1683 kbps for hub). The difference boils down to how they operate. Ethernet Hub broadcasts the data to all the ports resulting in **high** re-transmissions, **bandwidth sharing** and **high collisions** in case of increased network congestion. Ethernet Switch, on the other hand, broadcasts the data to the correct port resulting in **low** re-transmissions, **dedicated bandwidth** for each port and **lower collisions**. Thus Ethernet Switch has **higher throughput** and thereby **higher** effective bit rate.

2.5 Discussion

No problems were encountered in the Wireshark portion of the project.